



Influence of the configuration of heat exchangers on the performance of ORCs:

a first step towards a system optimization

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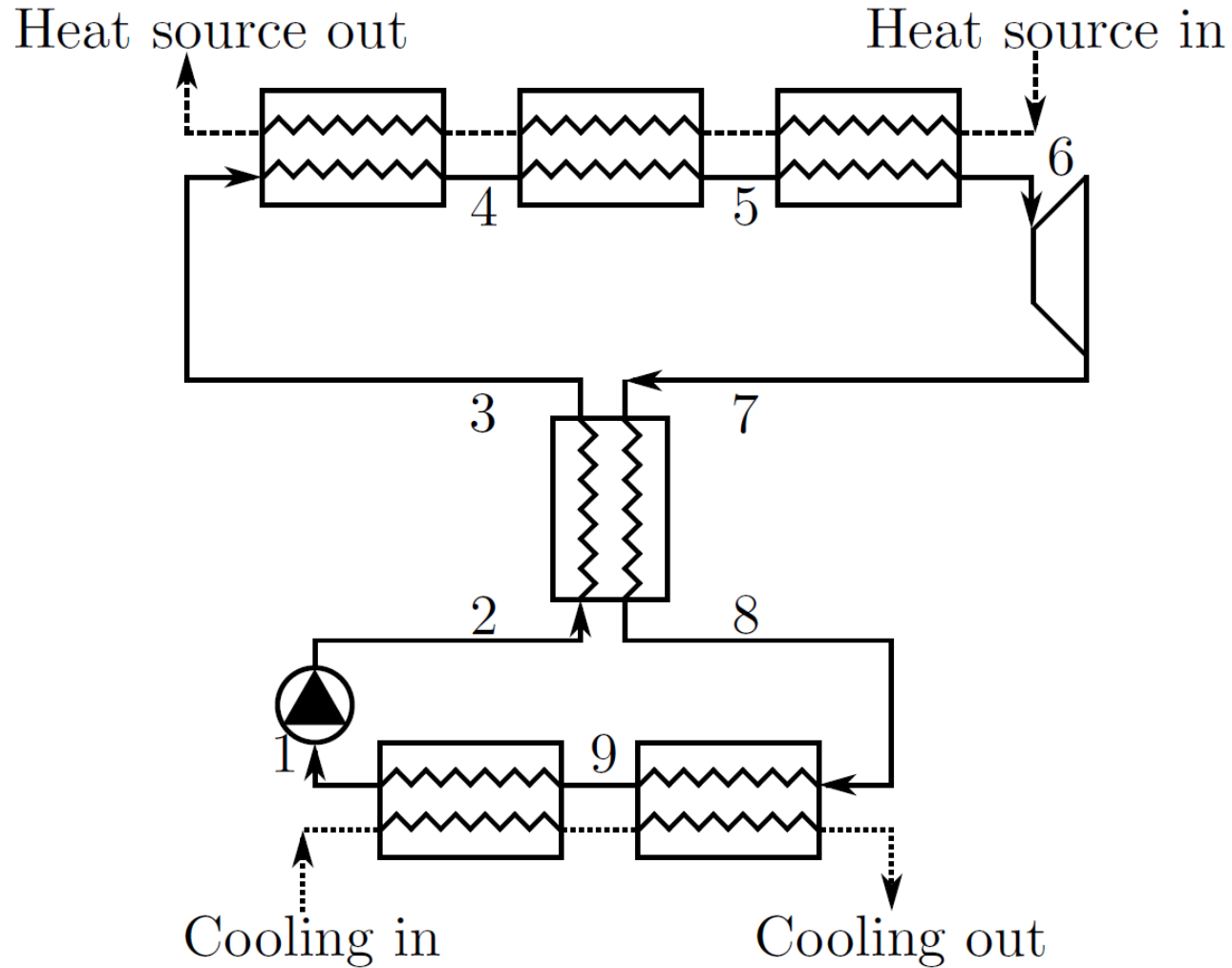
- Optimization for ORCs:
 - Cycle: temperatures, pressures, ...
 - or
 - Components: turbine, cooling system, heat exchangers, ...
- ⇒ Assumptions
- System optimization:
 - Combine cycle- and component optimization
- ⇒ Eliminate many assumptions

- System optimization with heat exchangers:
 - Shell-and-tube heat exchangers
 - Plate heat exchangers
- ⇒ Pinch-point ΔT , pressure drop, condenser temperature, ... are results

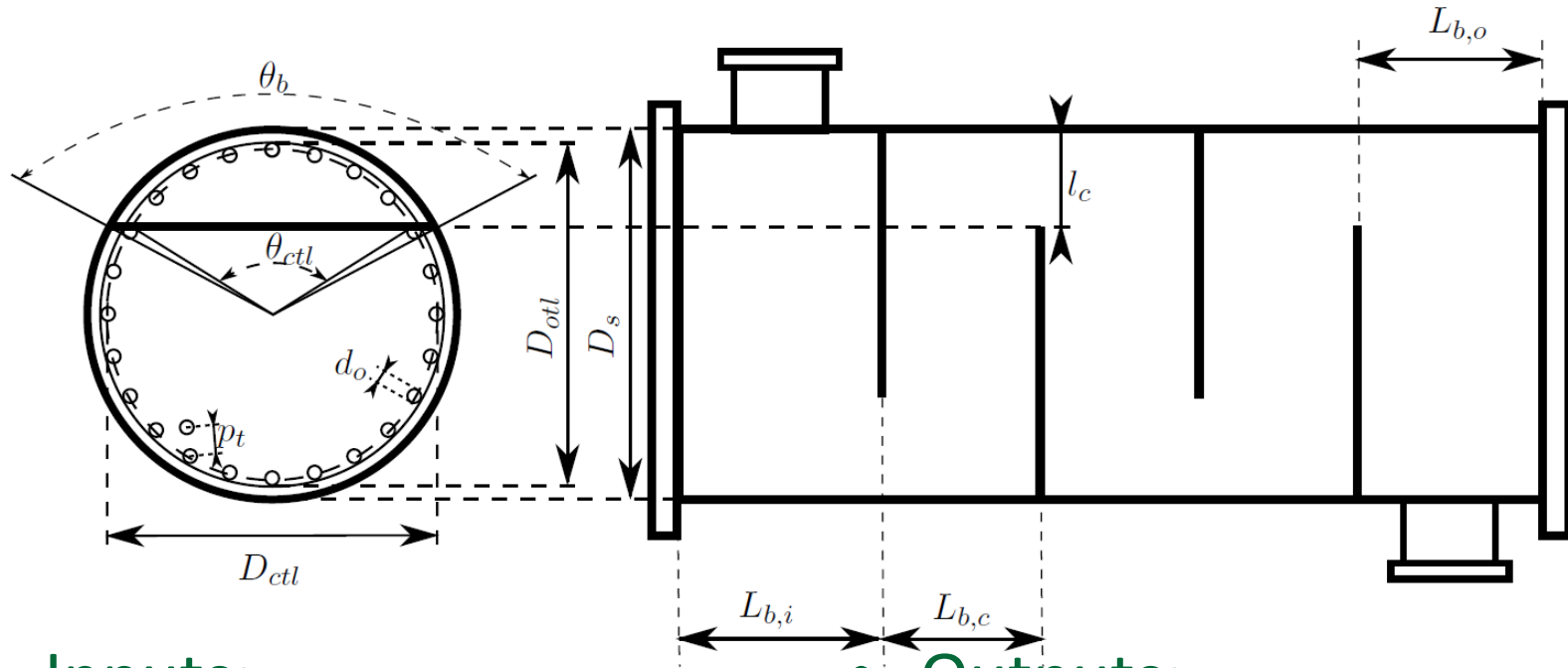
- Introduction
- ORC-model
- Heat exchanger models:
 - Shell-and-tube heat exchanger
 - Plate heat exchanger
- Optimization method
- Results
- Conclusions



Single-pressure ORC



Shell-and-tube heat exchanger: Tema E



- **Inputs:**

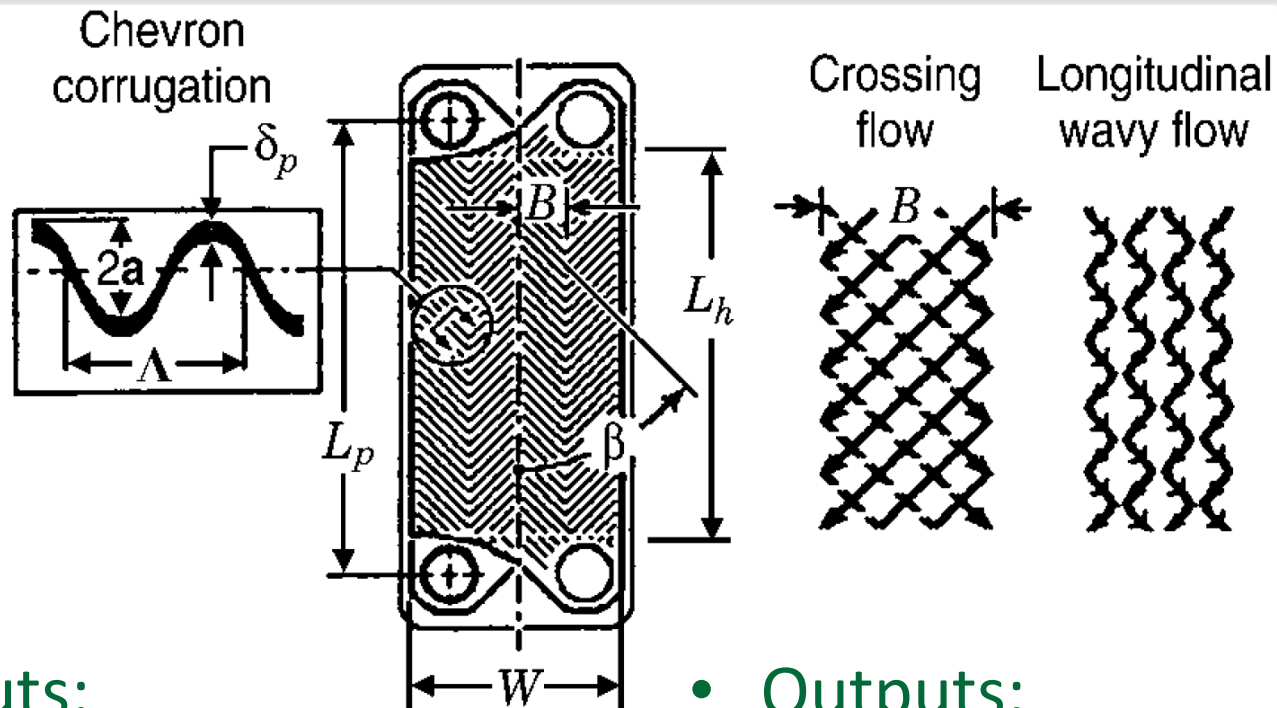
- Inlet states
- Requirement outlet state
- Geometry

- **Outputs:**

- Outlet states
- Size
- Heat transfer coefficient, ΔT , etc.



Plate heat exchanger: chevron corrugations



- Inputs:

- Inlet states
- Requirement outlet state
- Geometry

- Outputs:

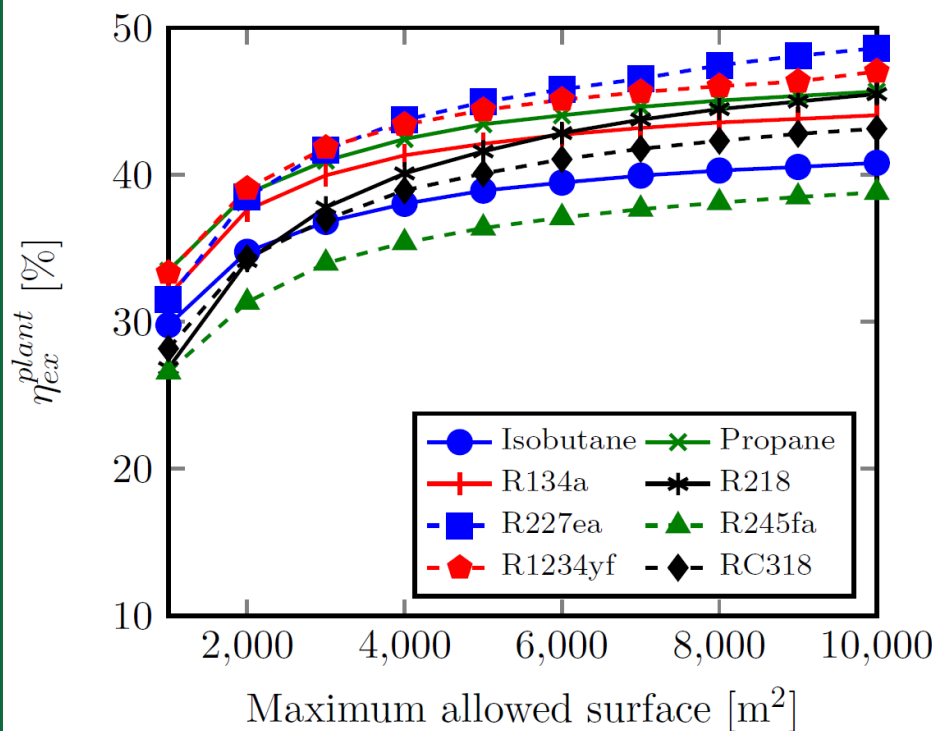
- Outlet states
- Size
- Heat transfer coefficient, ΔT , etc.

- Optimization variables:
 - Cycle:
 - Temperature before turbine
 - Pressure before turbine
 - Pressure before pump
 - Working fluid mass flow
 - Heat exchangers:
 - 4/5 geometrical variables for every heat exchanger
- ⇒ Computationally difficult
- Gradient-based:
 - Automatic differentiation in reverse mode
 - Adaptation RefProp
- Extra constraint:
 - Maximum total heat exchanger surface

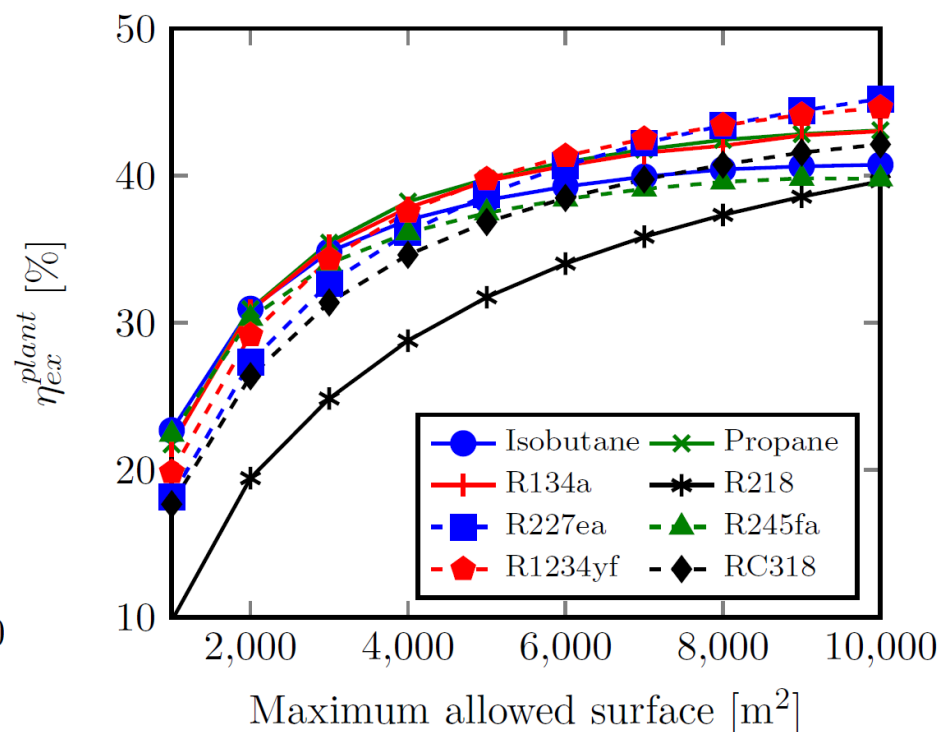
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- Heat source:
 - Water
 - 125° C
 - 100 kg/s
- ORC:
 - Simple/recuperated
 - 1 pressure level
 - $A_{\max} = 4000 \text{ m}^2$
- Cooling fluid:
 - Water
 - 20° C
 - 800 kg/s

- Plate

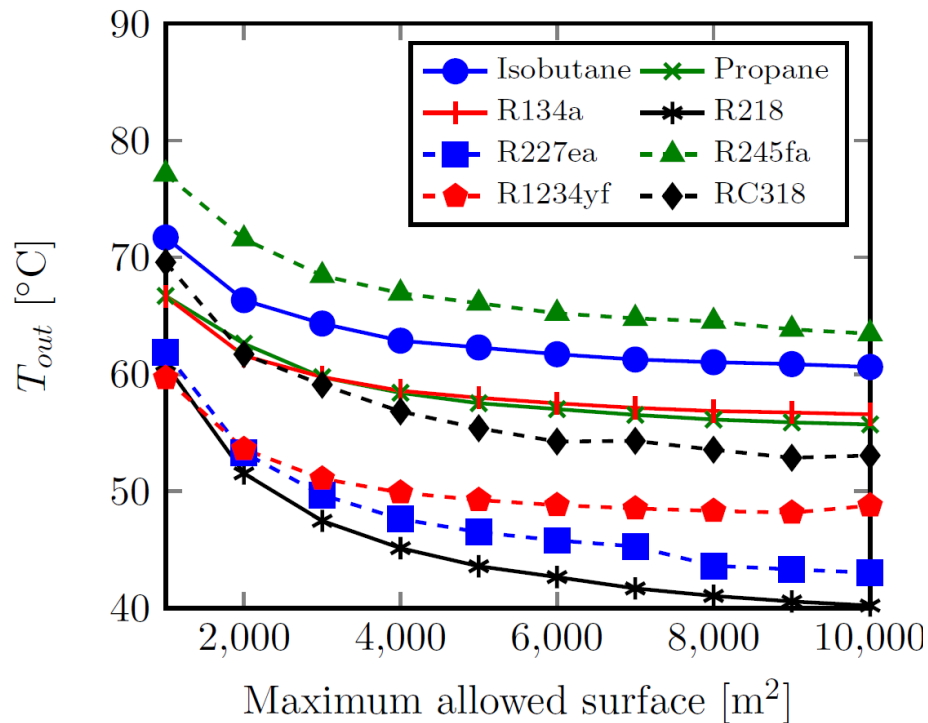


- Shell-and-tube, 90°

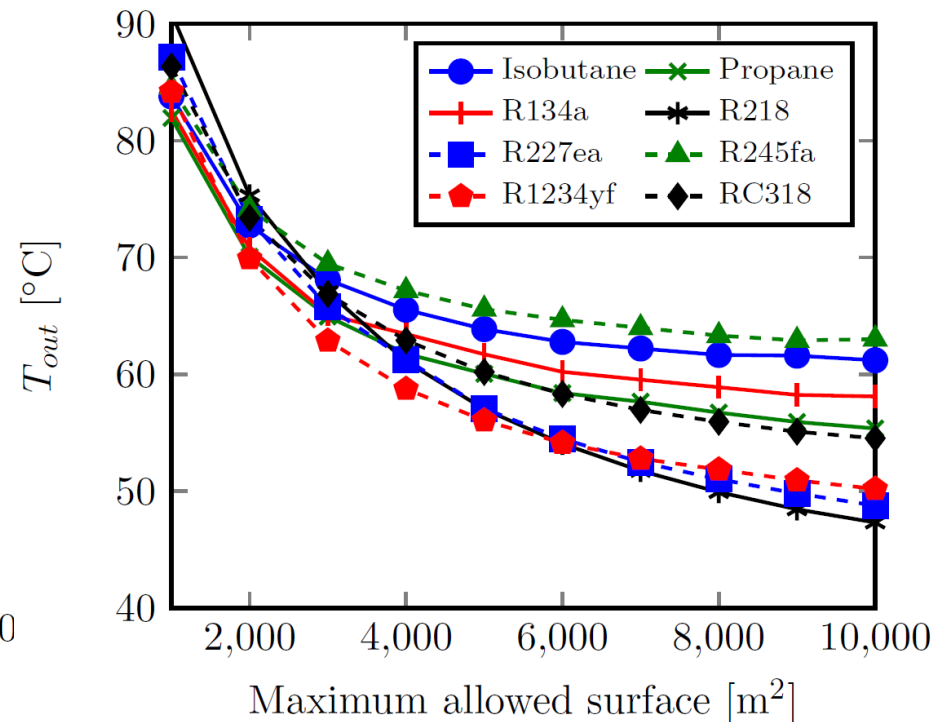


Influence maximum total heat exchanger surface (2)

- Plate

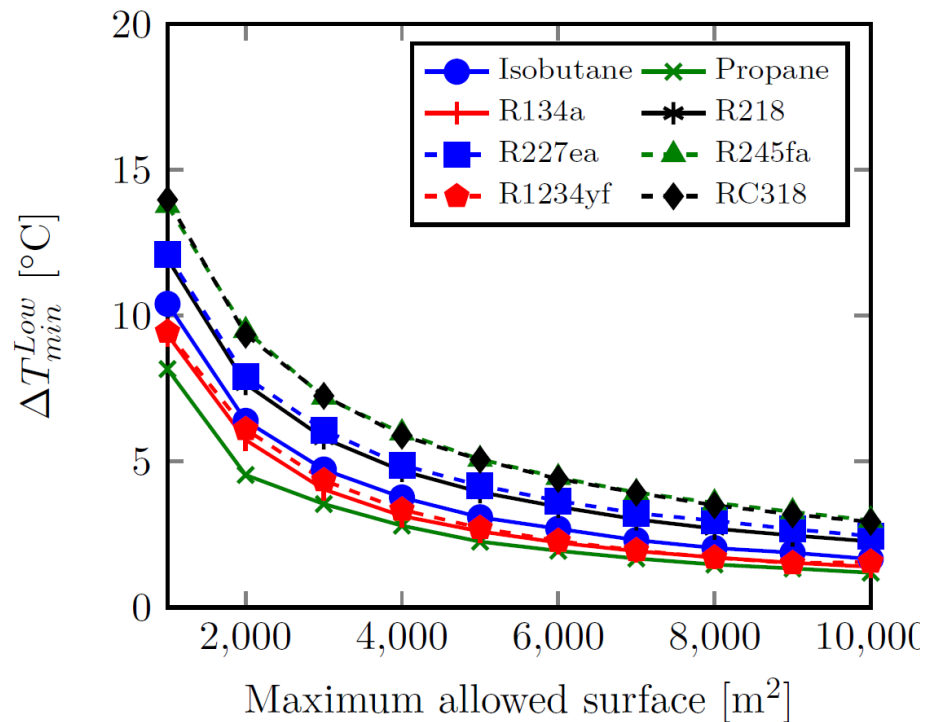


- Shell-and-tube, 90°

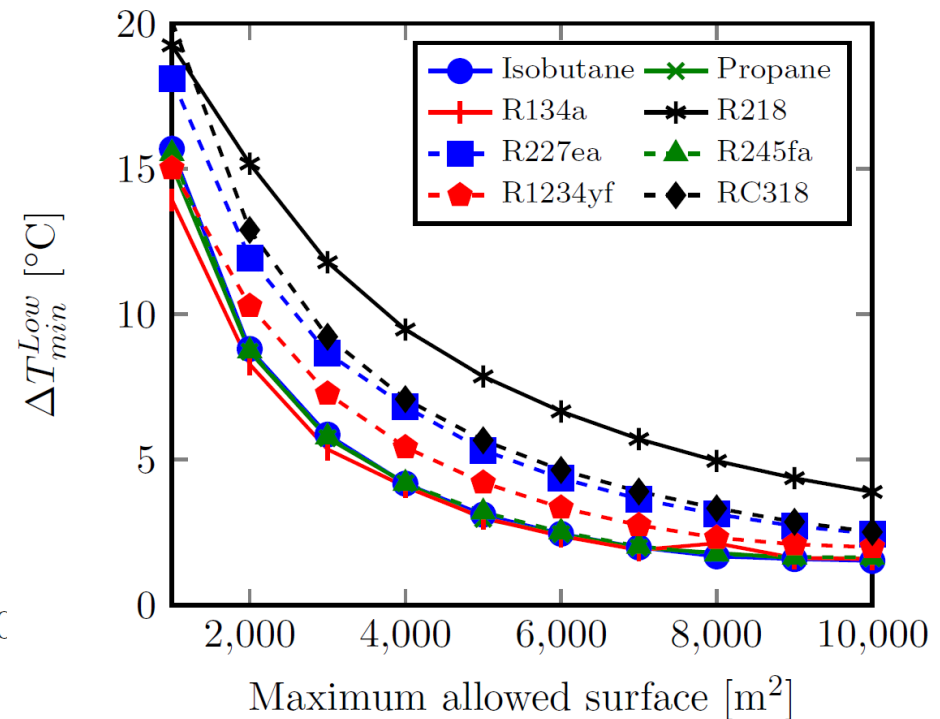


Influence maximum total heat exchanger surface (3)

- Plate

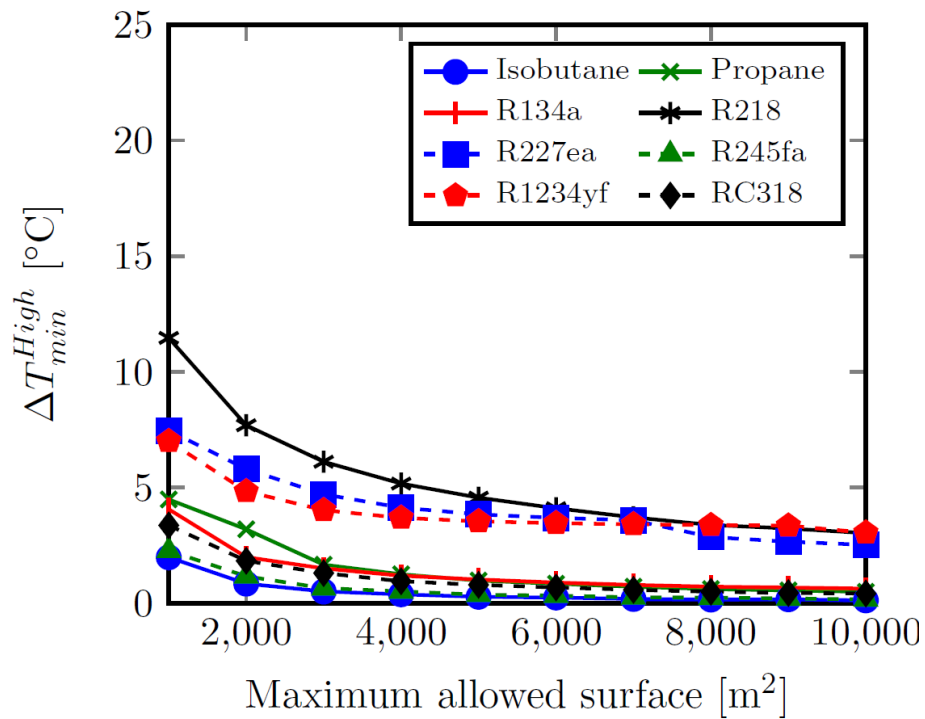


- Shell-and-tube, 90°

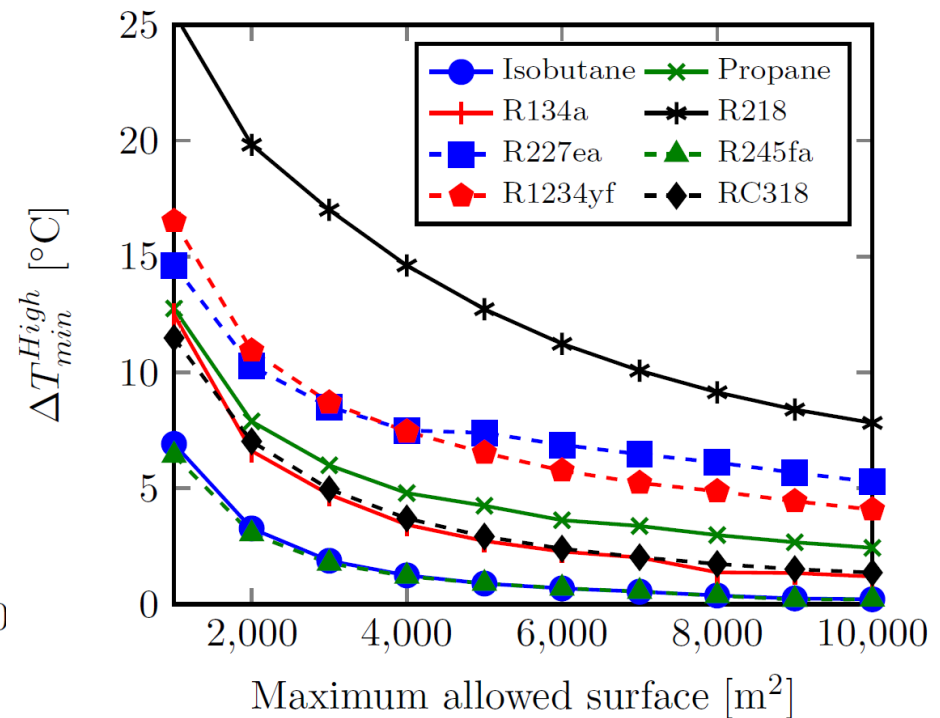


Influence maximum total heat exchanger surface (4)

- Plate

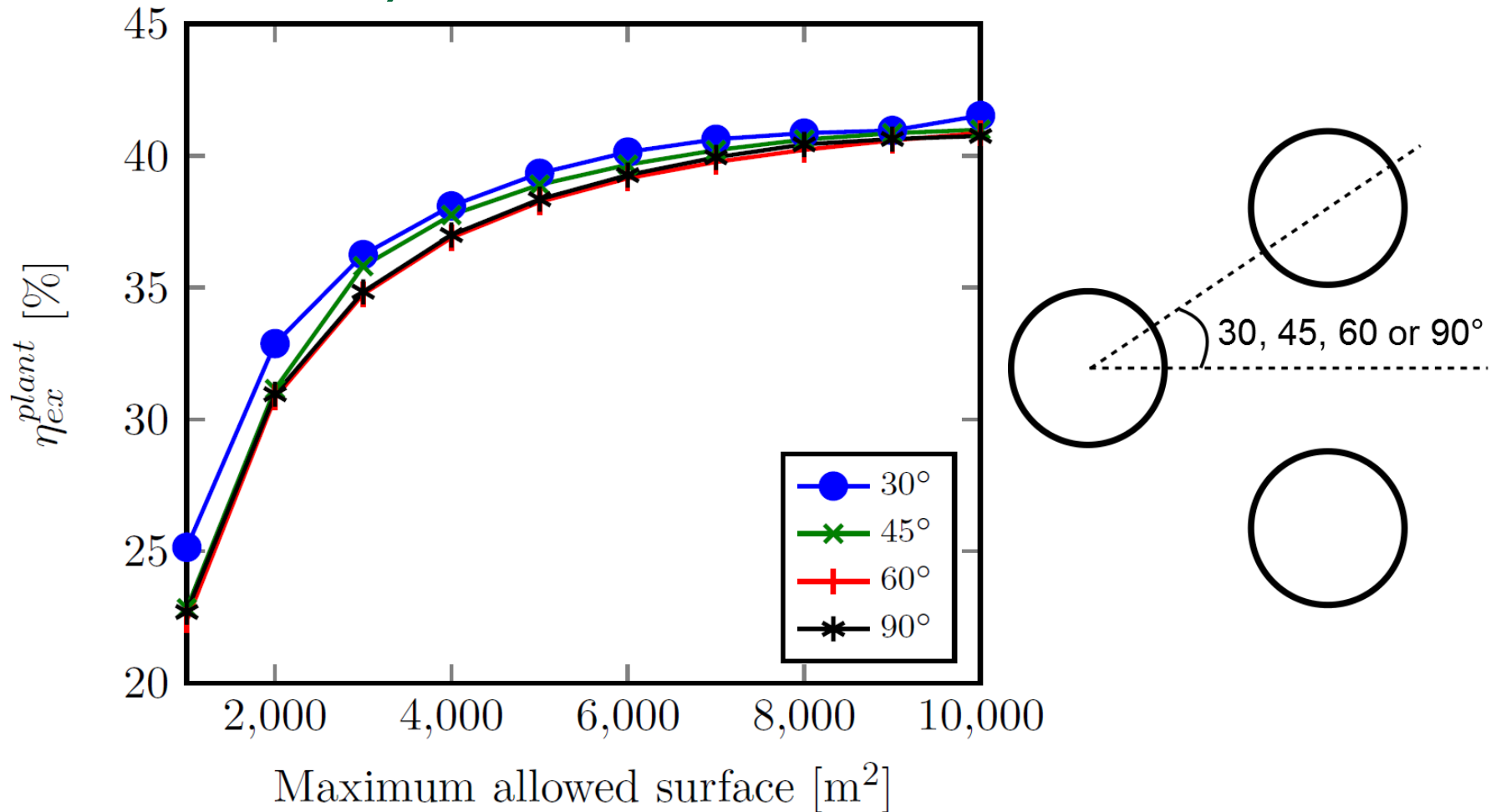


- Shell-and-tube, 90°



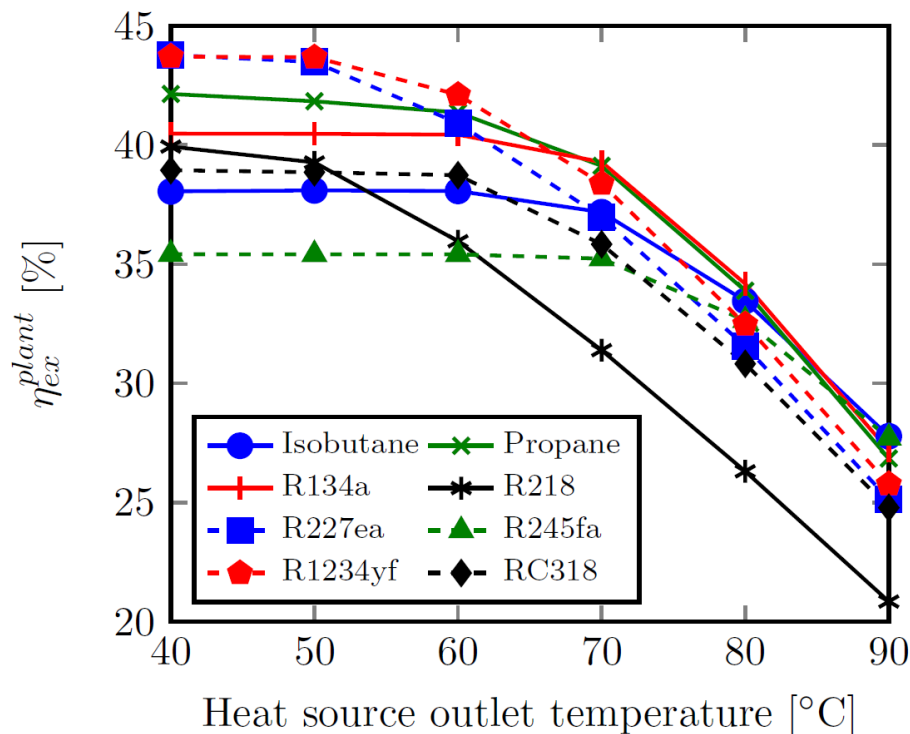
Influence configuration tubes

- Isobutane, shell-and-tube

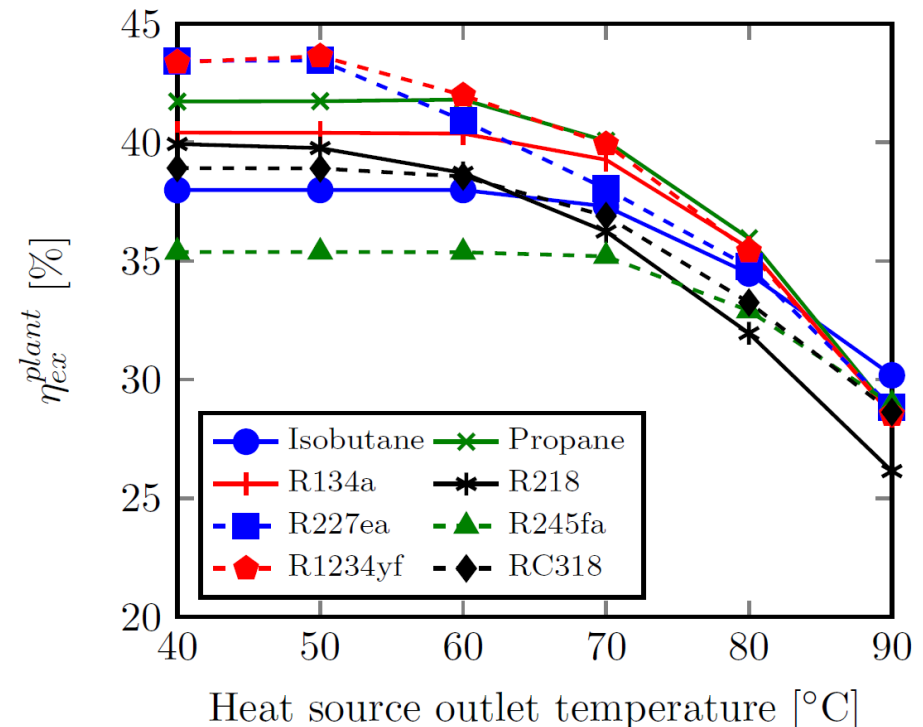


Influence heat source outlet temperature

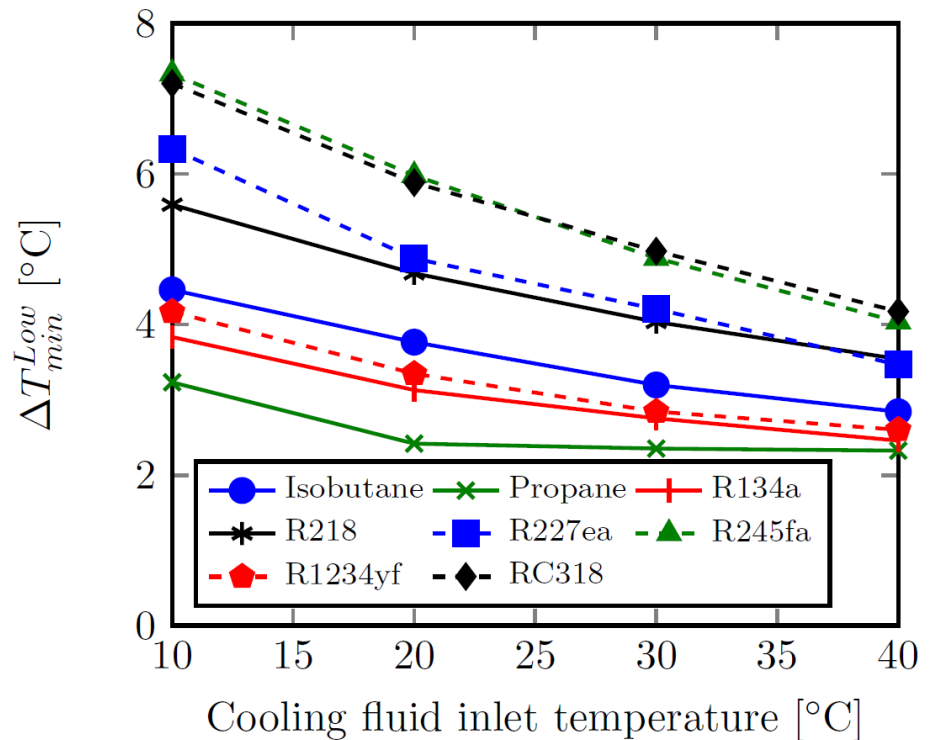
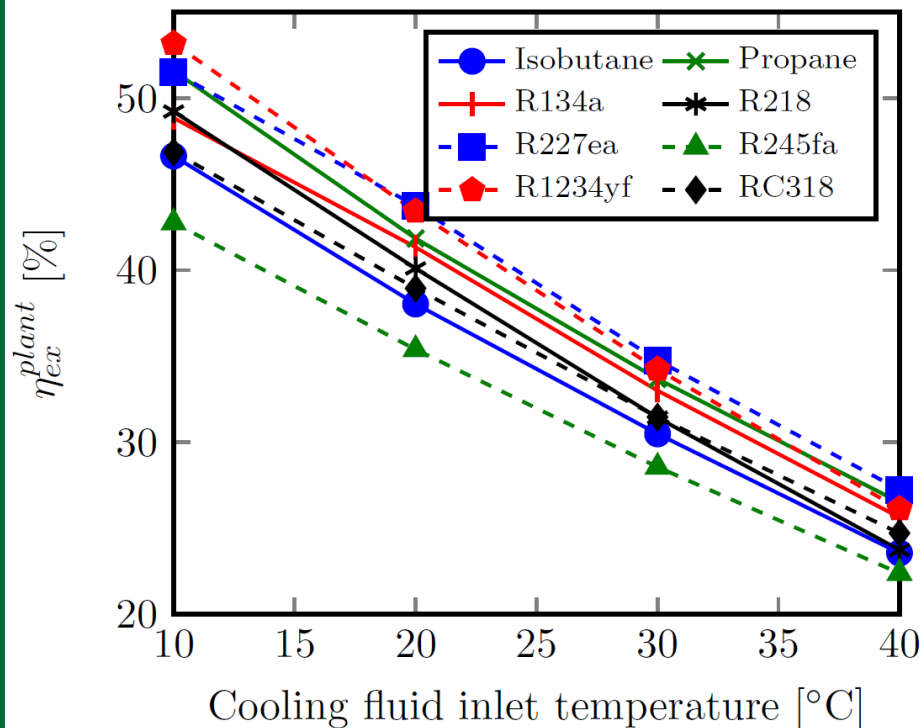
- Plate heat exchanger, simple



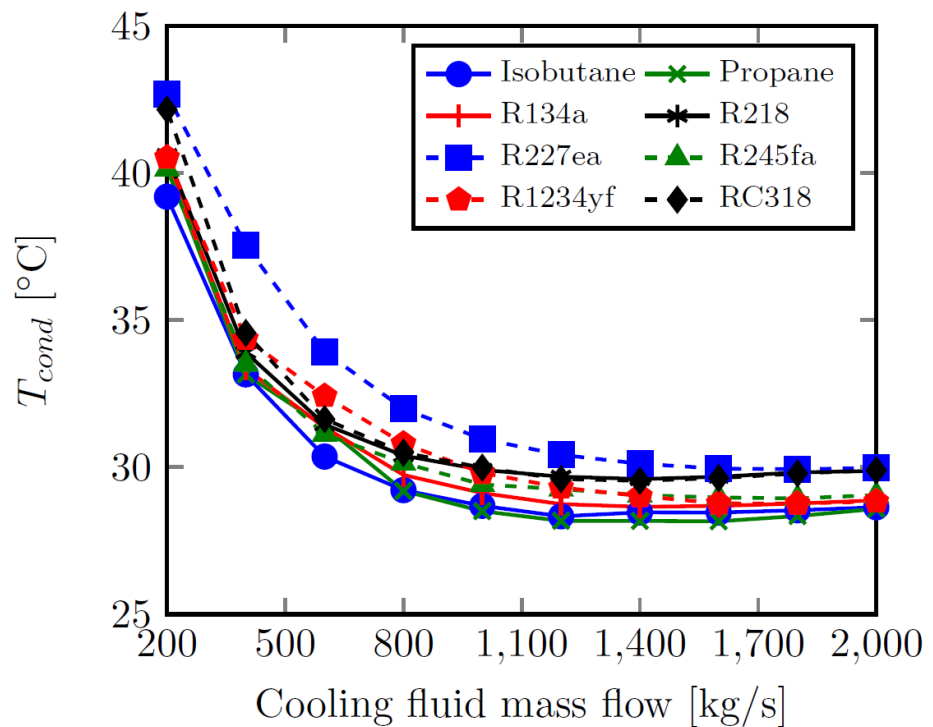
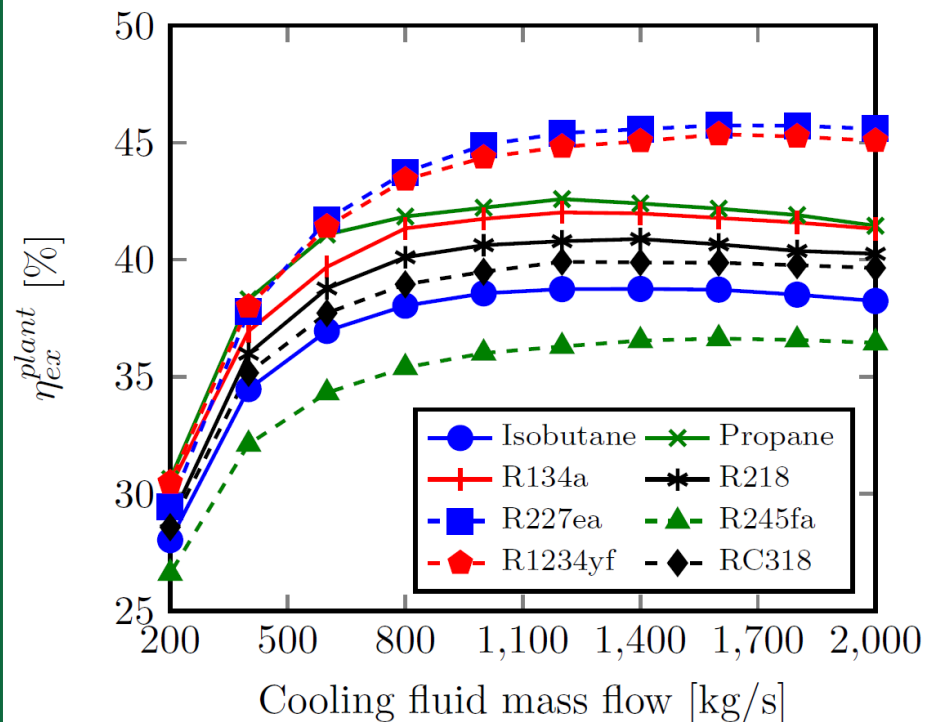
- Plate heat exchanger, recuperated



- Plate heat exchanger



- Plate heat exchanger



- System optimization of ORCs is possible
- Plate heat exchangers perform mostly the best
- Strong influence cooling fluid properties
⇒ Include cooling system in optimization
- Strong influence A_{\max}
⇒ Economic system optimization